



Indexing und Performance Tuning

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PostgreSQL Indexing

- Jeder hat schon einmal ein Telefonbuch Benutzt
- Jeder hat schon einmal Suchen durchgeführt

CREATE INDEX

test=# \h **CREATE INDEX**

Command: CREATE INDEX

Description: define a new index

Syntax:

```
CREATE [ UNIQUE ] INDEX [ CONCURRENTLY ] [ name ] ON  
table [ USING method ]
```

```
    ( { column | ( expression ) } [ COLLATE collation ] [ opclass ]  
[ ASC | DESC ] [ NULLS { FIRST | LAST } ] [, ... ] )
```

```
    [ WITH ( storage_parameter = value [, ... ] ) ]
```

```
    [ TABLESPACE tablespace ]
```

```
    [ WHERE predicate ]
```

Mehr als nur ein Baum

- PostgreSQL unterstützt 4 Arten von Indexes:

=> B-Tree

=> Gist

=> GIN

=> Hashes

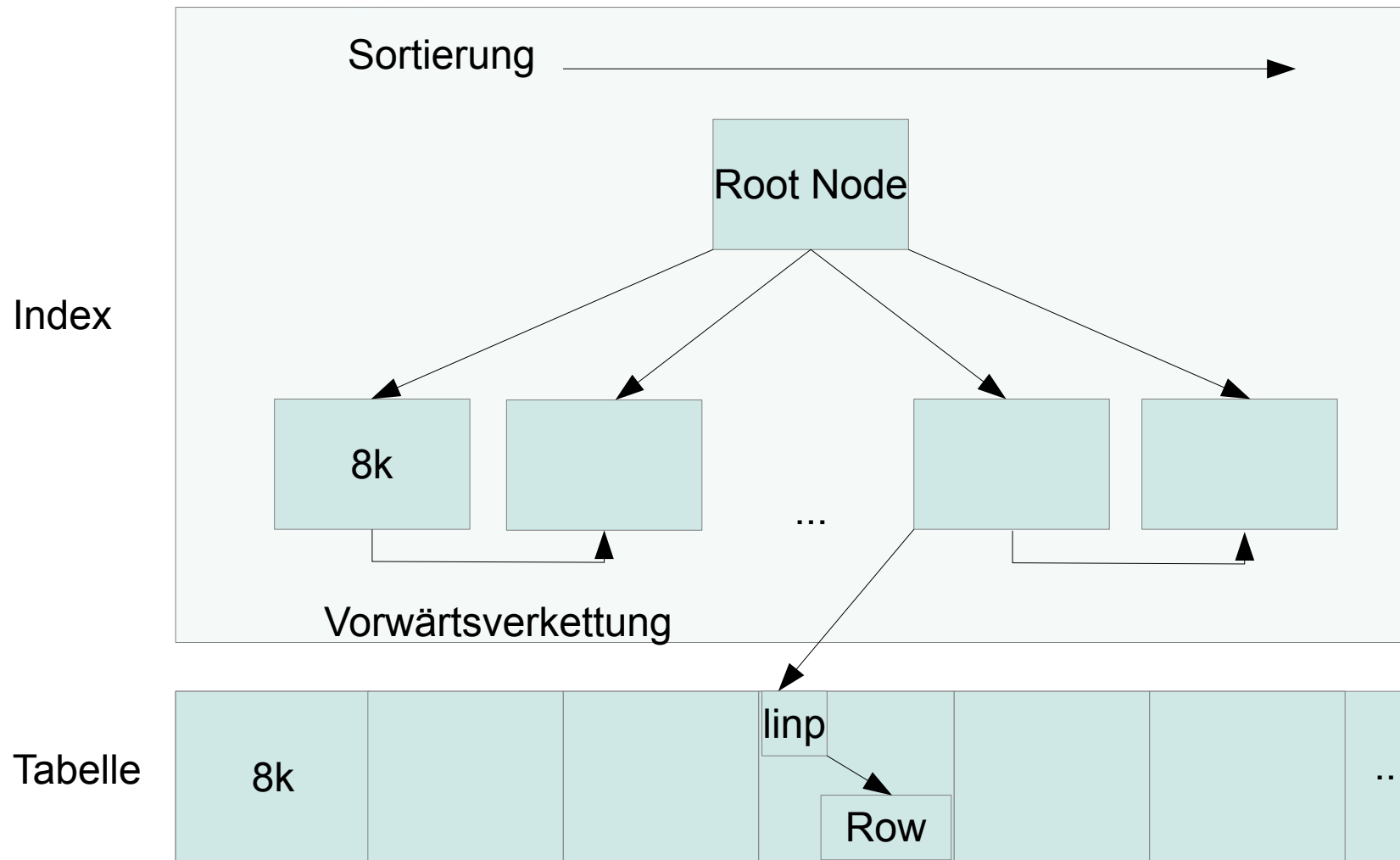
Wieso verschiedene?

- Nicht jeder “Algorithmus” passt für jede Art der Abfrage
- Verschiedene Indexes erfüllen verschiedene Aufgaben

B-Tree (1)

- B-Bäume sind die “typischen” Indices
- Wie ein “Telefonbuch”
 - => sortiert
 - => in “Pages” gespeichert

B-Tree (2)



B-Tree (3)

```
test=# CREATE TABLE t_test AS SELECT *  
      FROM generate_series(1, 100000) AS x;  
SELECT 100000
```

```
test=# CREATE INDEX idx_x ON t_test (x);  
CREATE INDEX
```

```
test=# EXPLAIN SELECT * FROM t_test ORDER BY x LIMIT 10;  
      QUERY PLAN
```

```
Limit (cost=0.00..0.44 rows=10 width=4)  
  -> Index Scan using idx_x on  
      t_test (cost=0.00..4376.26 rows=100000 width=4)  
(2 rows)
```


- Wie sortiert man Gartenteiche?

- Geodaten sind nicht sinnvoll sortierbar
 - => B-Tree ist folglich ungeeignet
- alternativ dazu arbeitet man eher mit “contains” als mit “<” und “>”.

- Gist verwendet man für ...

=> Geodaten

=> Volltextsuche

=> etc.

- spezielle Traversierungsstrategie ermöglicht "Umkreissuche" via Gist
- Beispiel:

```
test=# SELECT x, 1000 <-> x AS dist  
       FROM t_test ORDER BY 1000 <-> x LIMIT 5;
```

x	dist
1000	0
1001	1
999	1
1002	2
998	2

(5 rows)

GIN / Hashes

- Hashes sind in der Praxis eher selten
- GIN (“Inverted Index”) kann für Volltextsuche verwendet werden.

Wenn das nicht reicht?

- PostgreSQL erlaubt die Definition sogenannter “Operator Classes”
- Definition eigener Indizierungsstrategien

Operator classes (1)

- Beispiele:

=> Wie sucht man in Genomen?

=> Wie findet man ähnliche Farben?

=> Wie sortiert man Produktnummern?

=> Sollen Eilzüge vor Regionalzügen gereiht sein?

Operator classes (2)

- Jeder Index hat unterschiedliche “Strategien”, die man je nach Bedarf bauen kann.

Operator classes (3)

- B-Tree:

less than	1
less than or equal	2
equal	3
greater than or equal	4
greater than	5

Operator classes (4)

- Gist:

strictly left of	1
does not extend to right of	2
overlaps	3
does not extend to left of	4
strictly right of	5
same	6
contains	7
contained by	8
does not extend above	9
strictly below	10
strictly above	11
does not extend below	12

- Mehr als ein Index pro Abfrage:

```
test=# explain SELECT * FROM t_test WHERE x = 3 OR x = 4;  
          QUERY PLAN
```

Bitmap Heap Scan on t_test (cost=8.54..16.16 rows=2 width=4)

Recheck Cond: ((x = 3) OR (x = 4))

-> BitmapOr (cost=8.54..8.54 rows=2 width=0)

-> Bitmap Index Scan on idx_x (cost=0.00..4.27 rows=1 width=0)

Index Cond: (x = 3)

-> Bitmap Index Scan on idx_x (cost=0.00..4.27 rows=1 width=0)

Index Cond: (x = 4)

(7 rows)

Functional Indexing

- Indexes auf Funktionen

```
test=# CREATE INDEX idx_cos ON t_test ( cos(x) );  
CREATE INDEX
```

```
test=# explain SELECT * FROM t_test WHERE cos(x) = 0;  
QUERY PLAN
```

```
Index Scan using idx_cos on t_test (cost=0.00..8.28 rows=1 width=4)  
  Index Cond: (cos((x)::double precision) = 0::double precision)  
(2 rows)
```

Putting it all together

SEARCH THE BIBLE

Search in the Bible

Search

Legend: ■ 0 - 1 ■ 1 - 2 ■ 2 - 3 ■ 3 - 4 ■ 4 - 5 ■ 5 - 6 ■ 6 - 7 ■ 7 - 8 ■ 8 - 9 ■ 9 - 10

The Gospel According to St. Mark

Score: 6.9227

After two days was the feast of the passover, and of unleavened bread: and the chief priests and the scribes sought how they might take him by craft, and put him to death. But they said, Not on the feast day, lest there be an uproar of the people. And being in Bethany in the house of Simon the leper, as he sat at meat, there came a woman having an alabaster box of ointment of spikenard very precious; and she brake the box, and poured it on his head. And there were some that had indignation within themselves, and said, Why was this waste of the ointment made? For it might have been sold for more than three hundred pence, and have been given to the poor. And they murmured against her. And Jesus said, Let her alone; why trouble ye her? she hath wrought a good work on me. For ye have the poor with you always, and whensoever ye will ye may do them good: but me ye have not always. She hath done what she could: she is come aforehand to anoint my body to the burying. Verily I say unto you, Wheresoever this gospel shall be preached throughout the whole world, this also that she hath done shall be spoken of for a memorial of her. And Judas Iscariot, one of the twelve, went unto the chief priests, to betray him unto them. And when they heard it, they were glad, and promised to give him money. And he sought how he might conveniently betray him. And the first day of unleavened bread, when they killed the passover, his disciples said unto him, Where wilt thou that we go and prepare that thou mayest eat the passover? And he sendeth forth

him: but woe to that man by whom the Son of man is betrayed! good were it for that man if he had never been born. And as they did eat, Jesus took bread, and blessed, and brake it, and gave to them, and said, Take, eat: this is my body. And he took the cup, and when he had given thanks, he gave it to them: and they all drank of it. And he said unto them, This is my blood of the new testament, which is shed for many. Verily I say unto you, I will drink no more of the fruit of the vine, until that day that I drink it new in the kingdom of God. And when they had sung an hymn, they went out into the mount of Olives. And Jesus saith unto them, All ye shall be offended because of me this night: for it is written, I will smite the shepherd, and the sheep shall be scattered. But after that I am risen, I will go before you into Galilee. But Peter said unto him, Although all shall be offended, yet will not I. And Jesus saith unto him, Verily I say unto thee, That this day, even in this night, before the cock crow twice, thou shalt deny me thrice. But he spake the more vehemently, If I should die with thee, I will not deny thee in any wise. Likewise also said they all. And they came to a place which was named Gethsemane: and he saith to his disciples, Sit ye here, while I shall pray. And he taketh with him Peter and James and John, and began to be sore amazed, and to be very heavy; And saith unto them, My soul is exceeding sorrowful unto death: tarry ye here, and watch. And he went forward a little, and fell on the ground, and prayed that, if it were possible, the hour might pass from him. And he said, Abba, Father, all things are possible unto thee; take away this cup from me: nevertheless not what I will, but what thou wilt. And he cometh, and findeth them sleeping, and saith unto Peter, Simon, sleepest thou? couldst not thou watch one hour? Watch ye and pray, lest ye enter into temptation. The spirit

**Herzlichen Dank für
Ihre Aufmerksamkeit**

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Finally ...

Wir suchen Mitarbeiter !

Bewerbungen bitte an
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